

# HIGH LEVEL WASTE

## **What is it?**

High-level waste, or HLW, is the radioactive, chemical material left over when spent nuclear fuel is reprocessed.

## **How is it created?**

HLW is produced when spent nuclear fuel is reprocessed to recover uranium or plutonium. The United States no longer reprocesses spent nuclear fuel, but some other countries still do.

Reprocessing at the INEEL involved dissolving spent fuel in acid, then chemically extracting the uranium. The liquid that remains is very acidic, highly radioactive and contains chemicals which make it a hazardous waste. Because it is hazardous AND radioactive, it is a “mixed waste.”

All of the regulations that apply to radioactive wastes and all of the regulations that apply to hazardous waste apply to “mixed wastes.”

When HLW is created, it is a liquid. Much of the HLW at INEEL has been treated to make it a solid and reduce its volume. The treatment was done by a facility called a calciner, and the solid resulting from the treatment is called calcine. Making liquid waste into a solid is a significant goal of the environmental management plan at INEEL, and a requirement of the Settlement Agreement.

## **How much is there at INEEL?**

Spent nuclear fuel was reprocessed at INEEL from 1953 to 1992. Millions of gallons of HLW were produced.

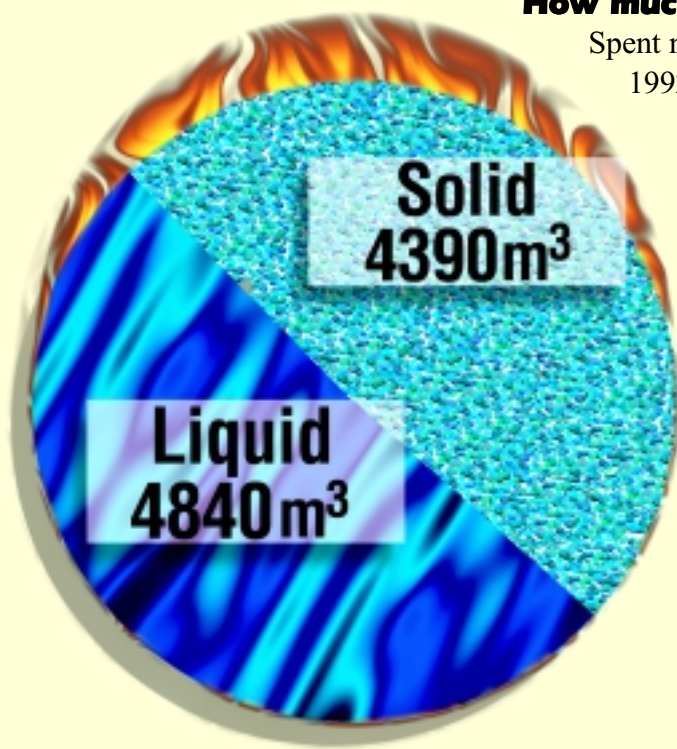
Much of that waste has been treated to make it a solid instead of a liquid. Today, there are about 1.3 million gallons (4,840 cubic meters) of liquid HLW and 4,390 cubic meters of solid “calcine.”

## **What does it look like?**

In a liquid form, it looks like blue Kool-Aid. In a solid form, calcine looks like laundry detergent or baking powder.

## **Where is it going to go?**

We do not know where it is going to go in the long run. The Settlement Agreement requires DOE to have all HLW treated and ready to leave Idaho by 2035. It's up to DOE to decide how to treat it and where it will go. Idaho is participating in the process DOE is using to decide how to treat the waste.



# EIS will help determine future management of INEEL high-level waste; may require change to Settlement Agreement

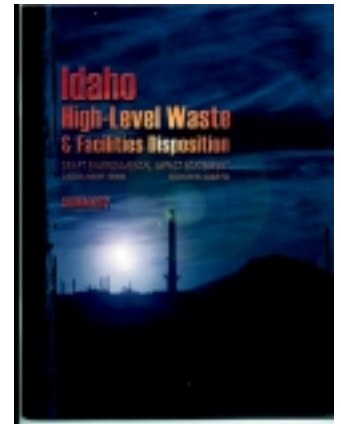
DOE and the State of Idaho jointly issued a draft environmental impact statement (EIS) that analyzes options for treating, storing and disposing the INEEL's high-level and related wastes. It also analyzes options for disposition of facilities used to manage this waste.

Because of the relationship to the Settlement Agreement and Idaho's regulatory authority over activities associated with managing high-level waste, DOE asked the State if it would be a "cooperating agency" and help prepare the EIS. The State accepted, but the memorandum signed by both parties establishing this arrangement recognized there may be areas of disagreement, in which case the EIS would give equal time to both positions.

Although the EIS includes options for managing high-level waste that are inconsistent with the Settlement Agreement, the preferred alternative in the Final EIS will comply with the spirit and timeframes of the Agreement. Based on public comment and technical and other policy factors, DOE and State representatives agreed on a preferred alternative for the Final EIS. The recommended treatment for the remaining INTEC tank farm liquids and calcine is direct vitrification (conversion to a glass form). For calcine treatment, DOE would research separations technologies to determine if removing key radionuclides prior to vitrification is technically and economically advantageous.

The Final EIS will be issued in the spring of 2001. If DOE ultimately chooses an option that is inconsistent with the Settlement Agreement, it must ask the State to approve the change, and the State cannot "unreasonably withhold approval." If DOE and the State agree, they will notify the federal court of the change. If DOE and the State do not agree, the federal judge will determine whether or not the change is appropriate.

One of the main reasons Idaho agreed to the 1995 Settlement Agreement was DOE's commitment to convert all liquid waste in the INTEC Tank Farm into solid form by 2012 and to treat this waste so it could be removed from Idaho by a target date of 2035. "We won't agree to revise the Settlement Agreement unless we're confident revisions will speed up the process of getting high-level waste safely treated and contained, and ultimately shipped out of Idaho," said Oversight Coordinator Kathleen Trever.



Above, the cover of the EIS Summary. Below, some of the materials Oversight published about the EIS.



Ann Dold, Oversight's Idaho Falls office manager, is the state's lead on the EIS. "Overall, our participation as a cooperating agency made for a better document and improved interaction with the public, I hope that translates to a better decision from everyone's perspective. For one thing, it's created more open communication with DOE and provided opportunities to resolve differences early in the process. True, there were times when our differences required extra time and resources to bring the document to a level acceptable to both parties. And on occasion, we had to remind DOE that we were a cooperating agency, entitled to participate in fundamental decisions about the EIS. But, looking back on a process that has taken over two years of concerted effort, I can now see the benefits and have gained an appreciation for the complexities DOE must deal with when preparing an EIS of this magnitude."

## Options for treating high-level waste

The options for treating high-level waste described in the draft EIS are:

- Do nothing, leaving liquid and calcined waste at INEEL indefinitely.
- Keep operating the calciner to convert all liquid waste into calcine and store the calcine at INEEL indefinitely.
- Separate the waste into different components and treat them individually at INEEL by converting them into glass or mixing them into grout.
- Treat the waste as a whole by mixing it into cement or converting it into glass or ceramic at INEEL.
- Transport calcined waste to Hanford for treatment and return treated waste to INEEL or disposal sites following treatment.

## What does separating the waste do?

Let's compare high-level radioactive waste to a can of vegetable soup. We could separate the soup into components by using chemicals or other methods to extract the tomato paste, potatoes and carrot juice and treat each of them individually. This would be a separations option. We could also treat the soup as a single unit, by freezing or cooking it. This would be a non-separations option.

The high-level waste could be treated by separations or non-separations methods. The EIS describes both chemical separations options and non-separations options. If a separations option is chosen, the separated parts of the waste could be sent to different disposal sites. If a non-separations option is chosen, all of the waste will end up at the same place.

INEEL high-level waste could go to Yucca Mountain if a repository is built there, but it must first be treated to meet that repository's "Waste Acceptance Criteria" or WAC. Since the facility isn't built, the WAC have not been identified. That makes it difficult to clearly evaluate waste treatment alternatives.

Further complicating the situation, legal limits set for Yucca Mountain and DOE policies may prevent the repository from accepting all INEEL waste. Any portions of the high-level waste at INEEL that could go to a place other than Yucca Mountain could reduce that burden. If separated out, some components of the INEEL's high-level waste could be disposed in WIPP or a low-level waste landfill. There are a few landfills in the United States run by private companies that could accept low-level radioactive waste.

There are benefits and risks to both "separations" and "non-separations" approaches. Waste treatment, including separating the waste into different components, has the potential to create more waste, more emissions, or more treatment facilities that have to be eventually closed down—each increasing risk. But waste treatment also has the potential to reduce total waste volume and/or make waste more stable, thus reducing transportation and long-term risks. Because INEEL HLW is not made from one uniform recipe, each treatment method could also encounter some technical challenges. That's one reason why deciding what treatment method is "best" is a difficult process.

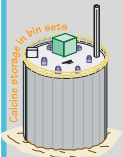
## Alternatives for closing HLW facilities

The options for closure and disposal of facilities used to store and treat high-level waste are:

- Do nothing.
- Remove or treat all wastes and contaminated items so they pose no future risk to workers or the public. This option would result in radiation levels as if the facilities had never been in place.
- Close facilities in accordance with state and federal requirements for landfills.
- Close facilities on a case-by-case basis, removing structures, decontaminating facilities and monitoring to reduce risks as necessary to meet health-based levels set for workers and the public.

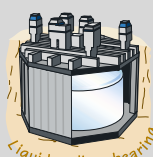
# Waste types, treatments, and disposal locations

## Waste types

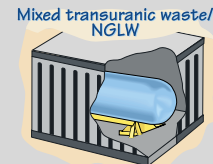


**Calcine**, which is a solid form of high-level waste that resembles dry laundry detergent, is stored in giant storage tanks called bin sets.

There are 7 bin sets at INEEL, holding 147,000 cubic feet of calcine. Most waste in those bin sets is **non-sodium bearing waste**, created during the first cycle in the reprocessing of spent nuclear fuel.



Waste from the second and third cycles of reprocessing and related decontamination activities, known as **sodium-bearing waste**, has a different chemical makeup. There are about 1.3 million gallons of this liquid waste at the INEEL. Calcining the remaining waste was difficult. Plagued by this and other problems, the calciner has been shut down.

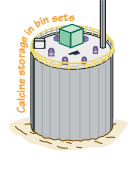
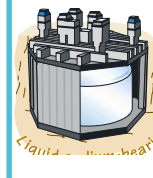


The INEEL continues to generate liquid waste from activities like facility decontamination. The liquid waste from current operations is called **newly generated waste**. This waste ranges from transuranic waste to low-level waste and is contaminated with hazardous chemicals, making it a "mixed" waste.

## Treatment technologies



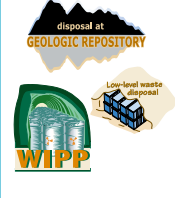
Calcining uses heat and airflow to convert liquid waste to a granular form. Liquid waste is sprayed as a fine mist into a heated chamber containing beads the size of coarse sand. The chamber circulates the beads like an air popcorn popper, and the heat evaporates the water from the liquid so it forms coatings on the beads. The continued popcorn popper motion constantly chips the coatings off the beads into flakes. The flakes then travel through transport tubes to storage bins.



To form a cement, calcine is mixed with clay, blast furnace slag, caustic soda and water. The cement would be hardened at elevated temperature and pressure.



Vitrification converts liquid waste or calcine granules into a more stable glass form using high temperatures. After heat evaporates the waste, each waste type is mixed with different combinations of sand and other materials and melted. The melted mixtures are poured into canisters and cooled to form glass. This method reduces volume by evaporating water but increases volume of sand and other materials.



Most of us are familiar with grout, the mortar that hardens to fill the tiles in our bathroom. To form grout, liquids or granules of different chemical compositions are combined with different recipes in a cement mixer. Grout can be poured into various containers where it hardens into a stable form. This method adds volume to the waste proportional to the additives in the grout process.



The hot isostatic press process uses high pressure and high temperature to convert calcine granules into a more stable glass-ceramic form. The high pressure works much like a trash compactor to compress the calcine so it requires about half its original volume. The high temperature, combined with the high pressure, changes the form of the waste much like a bread maker changes the form of flour, water, and other ingredients into a loaf of bread. The glass-ceramic form is more durable and less likely to release materials into the environment. Additives to the process also increase the waste volume in this method.



## Disposal options



The **Waste Isolation Pilot Plant** is a geologic repository located near Carlsbad, New Mexico. WIPP accepts only solid **transuranic waste**.

Some high-level waste contains transuranic elements. If the transuranic elements could be segregated, that part of the waste could go to WIPP. Newly generated transuranic liquid waste could also be sent to WIPP after it is solidified.



DOE has promised, and Congress has directed, that a permanent geological repository be constructed for high-level waste and spent nuclear fuel. DOE is currently studying Yucca Mountain, in Nevada, as a possible site for that repository. A draft EIS for this site was issued, and public comment taken. DOE is now analyzing the comments it received.



If separated out, some components could be disposed in a low-level waste landfill. There are a few privately run landfills in the United States that could take this waste. DOE is considering disposing of some of the waste at the INEEL, but the State believes this is inconsistent with the settlement agreement. DOE could also send the waste to landfills at other facilities.

# Evaluating options

The options in this EIS involve four main types of risk: risks from air emissions, risks to workers, risks from waste storage and disposal, and risks from transportation. When you evaluate these risks, you'll notice they are interdependent. For example, more processing at INEEL (more risk) means less waste is transported (less risk), while more transportation (more risk) means that more waste leaves Idaho (less risk).

Waste treatment using chemicals or heat can reduce volume and put waste in a safer form. But it can also release chemicals or radioactivity into the air. Treatment facilities must comply with state and federal environmental standards set to protect human health and the environment. However, all of the waste treatment facilities evaluated in this EIS could still have some level of air emissions and increase risk to the public and environment. INEEL and Hanford workers handle dangerous materials as part of their job. Risks to workers typically increase the longer they are exposed to hazards and the closer the hazards are. Alternatives that involve more waste handling usually involve more risks to workers.

Transportation risks are risks to transportation workers (such as drivers and inspectors) and to people traveling or living along the route. Transportation risks from radioactive materials depend on how long someone is exposed to the material and how far away they are. For example, the driver of the truck has a greater risk than someone riding in a car that passes the truck. Transportation risks also depend on the type of material and shipping container. Transportation of radioactive and hazardous wastes must meet federal and state standards established to protect human health and the environment, but each shipment still poses some degree of risk.

Risks from long-term storage or disposal continue as long as waste is present. They relate to the potential for the breakdown of waste containers and migration of hazards to groundwater or air, where they can affect public health and the environment. The longer the waste is present, the greater the risk. So options that involve long-term storage or disposal on the INEEL may mean greater risk to area residents and the environment. For example, because the INEEL is over the Eastern Snake River Plain Aquifer, long-term waste storage or disposal on the INEEL increases risk to area groundwater and people who rely upon it.

Waste processing	Pros	Cons
<b>No action</b>	<i>little short-term air, INEEL worker and transportation risk</i>	<i>most long-term risk</i>
<b>Continued current operations</b>	<i>little transportation risk</i>	<i>high long-term risk; some short-term air and INEEL worker risk</i>
<b>Separations</b>	<i>long-term benefit; less transportation risk</i>	<i>some air and short-term INEEL worker risk</i>
<b>Non-separations</b>	<i>long-term benefit</i>	<i>some short-term transportation, air, and INEEL worker risk</i>
<b>Minimal INEEL processing</b>	<i>long-term benefit, air, and little short-term air and INEEL worker risk</i>	<i>some short-term transportation and Hanford worker risk</i>
Facilities closure	Pros	Cons
<b>No action</b>	<i>least worker risk</i>	<i>most long-term risk</i>
<b>Clean closure</b>	<i>most long-term benefit</i>	<i>greatest worker risk</i>
<b>Landfill standards</b>	<i>some long-term benefit</i>	<i>some worker risk</i>
<b>Performance-based</b>	<i>some long-term benefit</i>	<i>some worker risk</i>

# Yucca Mountain: a possible answer

Ask people how to manage spent nuclear fuel and high-level waste over the long term and you'll hear different answers. Some believe a permanent geologic repository should house this waste. Others think it should go to a central location where it can be monitored and retrieved if necessary. And others believe it should be stored near the reactors that create it. Congress chose the repository approach in 1982. Following Congress' direction, DOE is studying a single site, Yucca Mountain, Nevada as a possibility for a national geologic repository for high-level waste and spent nuclear fuel.

## Why a geologic repository?

Scientists have studied methods for permanent disposal of radioactive wastes for years, focusing on a geologic repository since 1957 when the National Academy of Sciences recommended a facility deep underground. In 1992 the Academy reaffirmed that decision. The question of whether to use a permanent disposal site or a site where waste could be retrieved is the subject of great debate.

## How would a repository work?

There is spent nuclear fuel and high-level waste in 34 states. Some of it is at commercial power plants. Other waste is at federal facilities like the INEEL. Waste would go to Yucca Mountain and be placed in tunnels in special disposal containers. Tunnels would allow waste to be placed about 1,000 feet below the surface and 1,000 feet above the water table. The repository concept relies on barriers to prevent radioactive material from posing health risks. Some of these barriers are natural, including the rock type, depth of disposal and dry climate. Other barriers would be engineered, man-made ones. The State of Nevada and others are opposed to the use of Yucca Mountain as the nation's spent fuel and high-level waste repository.

## Why is Idaho concerned?

If there's no place to take high-level waste or spent nuclear fuel, it will be difficult, if not impossible, to ship it out of Idaho. That's why Idaho is interested in seeing a geological repository opened, and in making sure that space is allocated for the wastes currently at the INEEL.

If a permanent disposal site is not open, these wastes could be taken to an interim site. But siting an interim site may be as difficult as siting a permanent one. Risks and public concerns inherent in transporting the waste might compel DOE to transport the waste only once, to a permanent disposal site.

## What's happening?

Under the scenario described in a draft Environmental Impact Statement DOE issued in 1999, the repository will not accept "mixed" waste, waste that is both radioactive and hazardous. INEEL's high-level waste is mixed waste. For the repository to accept mixed waste, it would need a hazardous waste disposal permit from the state of Nevada, a regulatory "delisting" from the U.S. EPA and the state of Nevada, or a congressional waiver of certain regulations.



Left, Yucca Mountain. It's about 100 miles northwest of Las Vegas, Nevada, on unpopulated federal land adjacent to a nuclear weapons test site. Center, a drill rig which helps researchers gather information about the rock underground. 72 boreholes, between 25 and 250 feet deep, were drilled between 1983 and 1986 as part of ongoing studies. Moisture content of the rock in the boreholes is measured monthly. Right: A tunnel-clearing machine excavates a tunnel. The excavation started in December 1997 and ended in October 1998.